The feat was so remarkable that the writer spent the ensuing hour and more in launching broad sheets of waxed tissue paper in an attempt to learn if the huge spiralling current thus discovered were permanent. For the papers, very thin and light, undoubtedly indicated closely the courses of air particles as they varied with the different "flights." More than a dozen flights were made, some of them so long that the papers were followed with some difficulty even with the help of six-power binoculars. Every flight showed more or less strikingly the spiralling path first noted. The number of complete turns made varied from one to three, the time of flight from about five to about eight minutes, the horizontal distance travelled from a few hundred feet to over six thousand. The most remarkable flight, which the accompanying sketch is intended to illustrate, lasted nearly seven minutes, covered the greatest horizontal distance in three rotations along the spiral, and ended, so far as could be seen, more than six thousand feet away with a descent from the blue behind Liberty Cap. The top of this peak is some sixteen hundred feet above the point at which the flight began. There is no question but what the spiralling motion thus observed, and which involves the rotation of a huge mass of air about a more or less horizontal axis, is a persistent phenomenon here on warm afternoons.

The axis of the roll lies roughly parallel to the north wall of the canyon and seems to slope rather sharply upward toward the east. Its diameter increases greatly with increased distance from the corner of the canyon where it begins; for the papers almost without exception flew higher on successive turns, while they reached nearly the valley bottom at each descent. This is due to the fact that the valley wall increases in height from the corner eastward. The roll occupies the north side of the valley only, since in their ascents all the papers passed close to the cliffs, or in other words close to the periphery of the roll, and in their descents never crossed the river to the south side. What the conditions were on the south side was not apparent.

The shapes of the courses of air particles along the spiral may be likened to the varying forms which a watch spring would take if drawn out in a more or less elongated spiral. The exact form of the courses indicated certainly depends on at least three factors: First the speed of the general air current up the canyon; second, the variations in the upward suction effect in the lee of the door-post spur, induced by variations in the strength of the overpassing current of the general stream; and third, the rather active heating of the north rock wall by the sun on clear days, with consequent rise of air. In cross section the spiral seems asymmetrical, the horizontal axis being considerably shorter than the vertical. A part of this is apparent rather than real, due to foreshortening; but not all, for the upward flights often carried the papers so high that they were followed with difficulty, flashing in the sun as they were, even with the aid of the glass, while as before noted they never crossed the stream to the south, which is horizontally less than a thousand feet from the upper cliffs on the north side of the canyon.

There was no observable constancy of relation between the number of rotations about the axis of the spiral and the horizontal distance or the time of flight. Some of the longer distance flights showed the smaller number of rotations, while short-time flights sometimes had the maximum number of rotations.

This vast spiral may presently make interesting flying for some venturesome air man, occupying as it does something less than half the cross section of a narrow canyon, up which sight-seeing and mail service by air to Merced Lake and Hotel may conceivably be put in operation. Flying a few hundred feet north of the Merced River probably would lead to trouble with the strong descending current there observed. By hugging the north wall of the canyon precarious advantage might be taken of the lively ascending current there to make a thousand or more feet of altitude in a few seconds, though the danger of the wing tip next the cliff being caught in more rapidly upward moving air than the other, and of serious consequences when the plane was caught suddenly in the upper current above the cliffs, might be considerable. The safer flying will undoubtedly be done on the south side of the river, or, indeed, well above all the canyons and crags with their turbulent air currents.

Not the least interesting item to the writer in observing the paper flights was the air battles waged by the swallows (?) against these strange invaders of their mountain air lanes. Each paper as it wheeled on its course became the object of violent attack by the excited birds, who continued their darting thrusts until distance left only the flashing papers visible.

A FOG PHENOMENON OF SAN FRANCISCO BAY.

By B. M. VARNEY.

[University of California, July 21, 1920.]

SYNOPSIS.

Occasionally when ocean fog is covering the land and the Golden Gate west of San Francisco Bay, a local fog bank [1] forms along the eastern shore of the bay while the rest of the region remains clear. Conditions of air and water temperature and of topography being seemingly unfavorable to the formation of fog in this zone, it is suggested that the fog may be due to forced rising of the humid westerly wind over convection currents, themselves cloudless, on the plain east of the bay, condensation resulting from this forced rise. This local fog bank disappears in the latter part of the day, due to the breakdown of the convection currents.

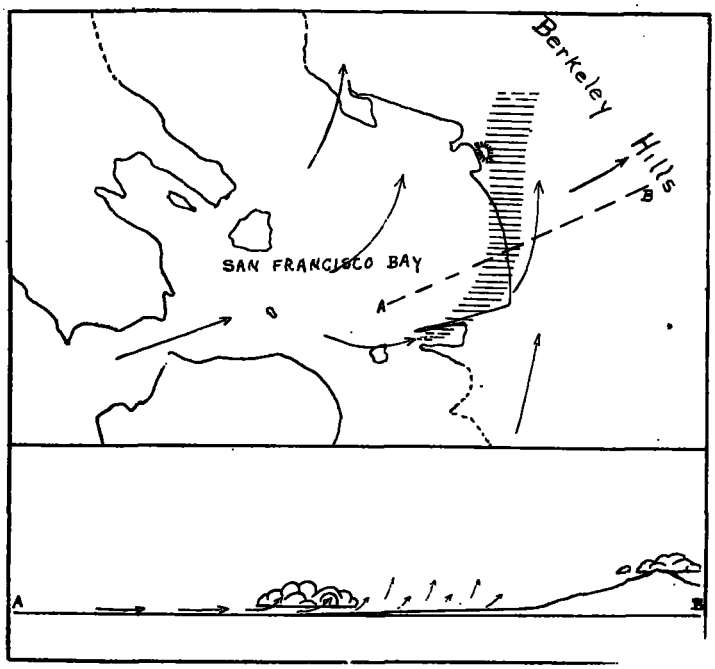

FIG. 1.—Map and cross section illustrating occurrence of fog bank over eastern side of San Francisco Bay and adjacent land. Shaded portion=approximate area of fog; arrow show estimated drift of air currents, from observations of fog and smoke. Vertical scale of section along line AB greatly exaggerated.

[1] This is, technically speaking, a band of strato-cumulus cloud, since it is not in contact with the ground. Such low cloud, forming over the plain and the Berkley Hills to the east, is locally known as "high fog," though it frequently hovers but a few yards from the ground.

An interesting detail concerning the well-known and much-described sea fogs of San Francisco Bay came again to the writer's attention not long since. The relations of land and water as they affect the behavior of the fog west of the bay are easily understood from the map herewith. Under the impetus of the prevailing west-southwest wind, when conditions outside on the Pacific Ocean are favorable, the fog often flows over the two peninsulas (accounting thereby for the proverbial chilliness of the San Francisco summer) and streams through the Golden Gate. Seen from the campus of the University of California, its spreading front entering the bay looks not unlike the front of a distant glacier. Quite commonly this front is for some hours kept "burned off" over the inner shores of the peninsulas and the relatively warm waters of the bay, leaving the broad expanse of water and the adjacent plain at the foot of the Berkeley Hills clear and sunny. But occasionally the following variant on these conditions occur, the major part of the bay and plain still remaining clear.

Beginning somewhere near Goat Island and extending northward toward the shore, a fog bank forms, of considerable density though never equaling that of the thick ocean fog. Its south end is almost always wispy and ragged, and its north end usually trails off in the wind up the plain to the northern part of the Berkeley Hills. There is clear air west of it over the bay, and clear air east of it over the sloping plain.

The conditions at first thought seem all against the formation of fog in that particular zone. The fog-laden sea air in its passage over the relatively warm waters of the bay is warmed enough for the fog in it to evaporate. The fog reforms, however, over the eastern part of the bay, in spite of the fact that the water is very shallow, and hence on sunny days is warmer than the deeper water on the west. There can be little, if any, chilling of the already cool incoming air as it crosses this belt of warmish water. It is not likely that the conditions of cold air over water that is warmer are here even approximated—the fog can scarcely come from that source. Furthermore, this fog bank is a quick-growing affair, often reaching one to two or three hundred feet in thickness within a few minutes after its beginning. And there is not, except in one restricted area, any height of land at the shore which would cause cloud formation by forcing the air to rise; such, however, is very commonly the case on a low hill (300 feet) at the edge of the plain in the northern part of the fog area.

The following explanation may be the correct one. Because of its passage over the belt of shallow, warmish water, the relative humidity of the air is somewhat increased as compared to the relative humidity over the cooler water of the bay. Therefore, only a very slight further cooling may be necessary to cause condensation. But a run over the land would have the opposite effect of reducing the relative humidity. Now, over the plain on sunny days convection currents are active, and they may be strong enough to function as a sort of buffer against and over which the cooler and moister air is forced to rise, the convection currents being at the same time weak and dry enough to cause of themselves little or no cloud formation. Condensation would take place then only on the western edge of the convection area, where the slight lifting of the cool and very humid air causes the necessary further reduction in temperature. The level of condensation is only a few yards above the house tops. Usually the air over the plain is clear, though occasionally the convection currents do form small rags of cloud drifting toward the hills on their way to merge with the major cloud mass about the summits.

In correspondence with the writer, Dr. C. F. Brooks suggests a possible additional cause for the condensation observed, namely, that the somewhat warmer air along the shore belt of shallow water, moving relatively slowly because of friction with the shore, is chilled to the condensation point by the admixture of faster-moving air from the west. This cause may well operate in conjunction with the convection barrier to produce the effect. As may be seen from the sketch, the more northerly part of the fog belt, trailing off over the land, is in a position favorable to such action. But the beginning point of the belt is somewhat offshore, and hence presumably not under the influence of this land-induced friction. The following is offered as a possible explanation of the condensation here. The convection barrier plus friction and mixture may cause a flattened wedge-shape mass of slightly slower-moving air to extend out some distance from the land, and so, to act as a sort of inclined plane up which the oncoming air from the west would move. The result would be convection cooling and mixture cooling combined, with the fog as a consequence.

As is commonly the case, on the last occasion when this fog bank formed it persisted until late afternoon, the air over the bay remaining clear and that over the plain for the most part clear. With the gradual weakening of convection the buffer effect here suggested gave way and the local fog bank disappeared. No longer forced to rise by the convection currents, and mixing instead with the warmer air over the plain, the moisture which had before been visible as fog now remained as vapor, until its rise over the higher summits of the hills again caused condensation.

MEASUREMENTS OF SOLAR RADIATION AT MADISON, WIS., WITH THE CALLENDAR PYRHELIOMETER.

By ERIC R. MILLER, Meteorologist.

(Weather Bureau Office, Madison, Wis., Apr. 13, 1920.)

SYNOPSIS.

Results of observations extending over nine years are summarized, and data of related phenomena of duration of bright sunshine and of cloudiness are given. A midsummer depression in the annual march of midday normal intensity is ascribed to a maximum of haze at that time, due in turn to the increased evaporation of water and stronger convection. Spring and autumn depressions in the annual march of sun and sky radiation upon a horizontal surface are explained as arising from the double maximum in the annual march of frequency of "Colorado lows." The suggestion is offered that this double maximum is produced by the most efficient cooperation at intermediate seasons of the stationary barometric depression in Northern Mexico and the eastward drift of the atmosphere, the annual oscillations of which are in opposite phases.

Introduction.—A continuous record of the intensity of the radiation from the sun and sky upon a horizontal surface has been kept automatically at Madison, Wis., since the beginning of April, 1911. Nine years' record is now available for study. Discussions of shorter periods have previously been published, and are listed at the end, (1), (2).

Instruments.—Callendar bolometric sunshine receiver No. 9864 has been used throughout the series of observations. This is the four-grid type, already described and illustrated by Kimball (3). Two different recorders have been used, Callendar Recorder No. 143 was used from